cyanide muscle curve; whilst its nervous contraction is still powerful in contrast to the utter loss of excitability in the latter.

The *latency* varies in the case of the different salts of ammonia. Thus, in stimulating the nerve, it is much lengthened in the chloride, and still more so in the cyanide—if the muscle be examined soon enough to yield response to nerve stimulation—it is increased slightly by ammonia, and by its nitrate and nitrite. In direct stimulation, the latency appears to be increased in the cyanide nitrate and nitrite, unaltered in the chloride and hydrocyanic acid, and unaltered or slightly decreased in the early stages of poisoning by ammonia.

VIII. "On Stratified Discharges. VI. Shadows of Striæ." By WILLIAM SPOTTISWOODE, President R.S., and J. FLETCHER MOULTON, F.R.S. Received May 27, 1881.

One of the most interesting questions connected with the subject of stratified discharges is this: What is the physical, as distinguished from the electrical, nature of the striæ themselves? Are they, in fact, to be regarded as aggregations of matter possessing greater density than the gas present in the dark spaces, or are they to be considered as indicating merely special local electrical conditions? The fact of their having a definite configuration, especially on the side which is turned towards the negative terminal of the tube, that of their temperature being higher than that of the dark spaces, the manner in which they are affected by solid bodies, and other considerations, all tend to give support to the view that the striæ are loci of greater density than the dark spaces. Still it can hardly be said that as yet any experimental proof of this has been given, sufficiently decisive to decide the question conclusively. And it is in the hope of contributing something towards the solution of this question that the following experiments are submitted to the notice of the Royal Society.

In the former papers of this series ("Proc. Roy. Soc.," vols. 23, 27), and in our memoirs "On the Sensitive State of Vacuum Discharges" ("Phil. Trans.," 1879, p. 155, and 1880, p. 561), we have described experiments which show how a discharge through a tube, whether sensitive or non-sensitive, may be affected in various ways by intermittent discharges *ab extra*. In the experiments now to be described the problem has been reversed, and it has been proposed to ascertain how far such an external discharge can itself be affected by the internal one. The discharge *ab extra*, however, presents such feeble luminosity, that it is not possible to come to any certain conclusions on this head by direct methods. But, as has been before pointed out,

the intermittent discharge *ab extra* is eminently calculated to produce Crookes' green phosphorescence, and the effect produced on this phosphorescence by the striæ of the internal discharge proves to be not only well marked, but even striking, and of this we now propose to give an account.

In the second of the two memoirs above quoted, Section 14, we studied "the effect of intermittent inductive action of an impulsive type upon continuous discharges." In the present instance the instrumental disposition was not very different from that which was there described. The two terminals of a Holtz machine were connected in the usual way with the two terminals of the tube, so as to produce a stratified discharge. A narrow strip of tin-foil, or a wire, was stretched along the tube opposite the column of striæ, but not extending much beyond it. The reason for the latter precaution will be mentioned below. The positive terminal of a second Holtz machine (in practice we used for this purpose a Töppler machine) was connected with the tin-foil, and the negative terminal with one (either) terminal of the tube. An air-spark, or interval across which sparks could pass, was interposed in the part of the circuit between the machine and the tin-foil. The effect of this arrangement was similar to that described in our first memoir, p. 170, viz., in the interval between two sparks the tin-foil and tube became charged like a Leyden jar; the tin-foil being the outer coating, charged positively, and the gas inside serving as the inner coating, charged negatively. When the spark passed across the interval mentioned above, the jar (*i.e.*, the tube) became discharged, and the electricity previously held bound on the two coatings was set free.

When the first (say the "internal") machine was not working, or when it was disconnected, *i.e.*, when no regular discharge was passing through the tube, then, whenever a spark passed at the second (or "external") machine, a negative discharge with its accompanying Crookes' radiation took place from the inside of the tube next the tin-foil, and the opposite side of the tube became covered with a sheet of green phosphorescence (the tube being of German glass). The length of the sheet was equal to, or very slightly greater than, that of the tin-foil strip, while the breadth was measured by the angular dispersion from the strip, as described in the second memoir.

When, however, other things remaining as before, a discharge from the internal machine was sent through the tube, and a good stratified column was produced, it was found that the green phosphorescence was entirely cut off from the parts of the tube opposite to the striæ, while on the parts opposite to the dark spaces it remained, in the form of phosphorescent rings, at least as brilliant as before. The experiment was repeated with various tubes with various degrees of strength of current, and with various densities of gas (produced by heating a chamber of

potash in connexion with the tube). It may be added that when, as is sometimes the case, through greater exhaustion, the striæ became feebler in illumination and less compact in appearance, the shadows cast by them lost proportionally in sharpness of definition and in completeness of extinction of the phosphorescent light.

The reason for not extending the tin-foil beyond the column of striæ is, that when this is done the negative discharge from inside the strip combines with that going on in the main dark space behind the anchored striæ in such a manner as to shorten the column by the length of the strip. When this takes place, as is often, although not always the case, the experiment is frustrated.

The brilliancy and definition of the phosphorescent rings may be increased by inserting a small Leyden jar in the circuit, care being taken that the jar shall discharge itself completely each time. If this is not the case, the main discharge is followed by subsidiary discharges, which tend to blur the effect. The angle of dispersion may be increased, or rather supplemented, by placing more than one strip on the tube, distant from one another by an angle of 90° or 120°. By this means the rings may be made to comprise the entire circumference of the tube.

It should be here mentioned that if the striated column be carefully examined at the moment when the external discharge passes, it will be noticed that the entire column (or more strictly speaking the part of it lying between the positive terminal and the end of the tin-foil nearest to the positive terminal) undergoes a slight displacement. This displacement amounts usually to half the distance between two striæ. The actual shadows cast in the green phosphorescence are those due to the displaced striæ, as may be easily verified.

It thus appears that the striæ are competent to cast shadows in the radiant showers issuing from the inside of the tube adjacent to the tin-foil, which part acts as a negative terminal. Many experiments have contributed to show that these radiant showers, although accompaniments of the discharge, are not carriers of the discharge; and that, having once issued from their source, they continue their own course irrespective of that of the discharge proper. They are in fact material showers, and, although not improbably charged with electricity, yet their ulterior course does not appear to depend on their electrical condition. Under these circumstances the most probable explanation of the phenomena above described appears to be that the showers are arrested by material obstacles in the shape of striæ; and consequently if that be the case, we here have an experimental proof that the striæ represent local aggregations of matter, and not merely special electrical conditions of the gas.